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ABSTRACT

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UNIVERSITY OF CALIFORNIA SAN DIEGO

OASIS Research Report #3

Prerequisite Courses as Predictors of Achievement in the Natural Sciences

February 1976

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Abstract

A study was conducted to determine the relationship between grades received in prerequisite biology, chemistry, mathematics, and physics courses and subsequent average grades received in science major areas. Seven major areas were investigated. Subjects were students who graduated from the University of California, San Diego (UCSD), in Spring, 1975, who had taken both their science major coursework and their lower division coursework at UCSD. The range of multiple correlations between prerequisite courses and average grades in major was .715 to .899. The results support the validity of prerequisite courses as predictors of success in major areas of study, even though the best predictors for success in a given field were not always courses in the same content area. Implications for future systems of diagnosis and prediction are made.

It is standard practice for science departments to require lower division mathematics and science courses as prerequisites to upper division coursework in the major. This usually corresponds to required sequences of courses in mathematics (calculus), physics, and chemistry. These courses purportedly serve three purposes: to provide the content that is fundamental to understanding upperclass work; to give students practice in quantitative problem solving techniques; and to select students who will actually enroll in the advanced coursework of particular disciplines.

If lower division prerequisites do in fact provide essential content and experience in quantitative problem solving strategies, then they can effectively perform the third function of screening. The extent to which lower division prerequisites serve the first two functions can be determined by the extent to which they can accurately predict achievement in the major. Conversely, if achievement in lower division prerequisite courses does not predict achievement in major area coursework, the validity of the functions of prerequisite courses could be called into question.

Method

Subjects

The subjects of this study consisted of 195 students who graduated from the University of California, San Diego (UCSD) in Spring, 1975, with majors in Applied Physics and Information Science (APIS), Applied Mechanics and Engineering Sciences (AMES)

Biology (Revelle College and Muir College curricula), Chemistry, Mathematics or Physics. All students who completed both lower division prerequisites and major area coursework at UCSD were included.

Procedure

The lower division prerequisite courses were determined from the UCSD catalog for each of the seven major areas. Transcripts of the subjects were analyzed and the average grade in each of the specified prerequisite areas (biology, chemistry, mathematics, and physics) for each major was computed for each student. The average grade in upper division courses within the major area was also computed for each student.[1] For each of the seven majors, a stepwise multiple regression analysis was used to obtain the multiple correlation between average grades in that major's lower division prerequisite courses and the average grade in upper division major area courses.

Results

Table 1 presents the results of the multiple regression analyses.

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[1] The average grade in upper division major area courses is sometimes called the major area grade point average. This term is not used herein to avoid confusion with cumulative GPA.

Table 1

Bivariate Correlations and Multiple Correlations Between Grades in Prerequisite Courses and Grades in Major Area of Study

Major Area	Prerequisite Areas				R	R^2	R^2 Corrected for Shrinkage[b]	N
	Biology[a]	Chemistry	Math	Physics				
AMES	----	.666*	.700*	.797**	.899**	.809	.727	11
APIS	----	----	.725**	.843**	.858**	.736	.688	14
Biology (Muir)	----	.642**	.437**	.736**	.783**	.614	.588	49
Biology (Revelle)	.294*	.624**	.598**	.422**	.768**	.589	.563	68
Chemistry	----	.307	.641**	.611**	.715**	.511	.444	26
Mathematics	----	----	.560*	.762**	.786**	.618	.559	16
Physics	----	.713*	.830**	.748**	.886**	.785	.693	11

* $p < .05$
** $p < .01$
[a] Blanks deonte course areas that are not prerequisite requirements for major.
[b] McNemar, Q. Psychological Statistics (4th ed.) New York: John Wiley, 1969.

Average grades in lower division physics courses were the best predictor of mean upper division grades in the AMES major ($r = .797$, $p < .01$). Mean lower division mathematics grades and mean lower division chemistry grades also correlated significantly with average grades in upper division AMES classes ($r = .700$, $p < .05$ and $r = .666$, $p < .05$). The combination of chemistry, mathematics, and physics lower division grades as predictors yielded a significant multiple correlation with mean upper division AMES course grades, $R = .899$, $p < .01$. This multiple correlation

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Footnote 'a' of Table 1 should read: "Blanks denote course areas that are not prerequisite requirements for major."

(corrected for shrinkage) accounted for 72.7% of the variance in upper division AMES grades as indicated by the coefficient of determination (R^2).

Average grades in lower division physics courses also had the highest correlation with mean upper division APIS grades ($r = .843$, $p < .01$). The average grade in lower division mathematics courses also correlated significantly with the average grades in upper division APIS classes ($r = .725$, $p < .01$). The combination of mean grades in lower division mathematics and lower division physics courses yielded a significant multiple correlation with average upper division APIS course grades, ($R = .858$, $p < .01$). The R^2 (corrected for shrinkage) indicated 68.8% of the variance in mean upper division APIS grades was accounted for by the mean grades in the lower division prerequisites.

Average grades in lower division physics courses had the highest correlation with average grades in upper division biology courses for students enrolled in the Muir Biology major ($r = .736$, $p < .01$). The average grades in lower division chemistry courses and math courses also correlated significantly with average grades in upper division biology courses ($r = .642$, $p < .01$ and $r = .437$, $p < .01$). The combination of average grades in lower division chemistry, mathematics, and physics yielded a significant multiple correlation with average grades in upper division biology courses for Muir Biology majors

($R = .783$, $p < .01$). The R^2 (corrected for shrinkage) indicated 58.8% of the variance in upper division Muir Biology course grades was accounted for by lower division chemistry, mathematics, and physics grades.

Average lower division chemistry grades had the highest correlation with average upper division biology course grades for students enrolled in the Revelle Biology major ($r = .624$, $p < .01$). Average lower division mathematics and physics grades also correlated significantly with upper division biology grades in the Revelle Biology major ($r = .598$, $p < .01$ and $r = .422$, $p < .01$). The correlation between lower division biology grades and average upper division grades in biology was significant at the .05 level ($r = .294$). The combination of average grades in lower division biology, chemistry, mathematics and physics courses yielded a significant multiple correlation with average grades in the upper division biology courses for students enrolled in the Revelle Biology major ($R = .768$. $p < .01$). This multiple correlation (corrected for shrinkage) corresponds to 56.3% of the variance in average upper division biology grades accounted for by the lower division prerequisite courses.

Average grades in lower division mathematics courses had the highest correlation with average grades in upper division chemistry courses ($r = .641$, $p < .01$). Average grades in lower division physics courses also correlated significantly with average grades in upper division chemistry courses ($r = .611$, $p < .01$).

Average grades in lower division chemistry courses did not correlate significantly with average grades in upper division chemistry courses ($r = .307$, $p > .05$). The combination of average grades in lower division chemistry, mathematics, and physics courses yielded a significant multiple correlation with average grades in upper division chemistry courses ($R = .715$, $p < .01$). The R^2 (corrected for shrinkage) indicated that 44.4% of the variance in average upper division chemistry course grades was accounted for by average grades in lower division prerequisite courses.

Average grades in lower division physics courses had the highest correlation with average grades in upper division mathematics courses ($r = .762$, $p < .01$). Average grades in lower division mathematics courses correlated significantly at the .05 level with average grades in upper division mathematics courses ($r = .560$). The combination of mean grades in lower division mathematics and physics courses yielded a significant multiple correlation with average grades in upper division mathematics courses ($R = .786$, $p < .01$). This multiple correlation (corrected for shrinkage) accounted for 55.9% of the variance in upper division mathematics course grades.

Average grades in lower division mathematics courses had the highest correlation with average grades in upper division physics courses ($r = .830$, $p < .01$). Average grades in lower division physics courses also had a significant correlation with average

grades in upper division physics courses ($r = .748$, $p < .01$). Average grades in lower division chemistry courses correlated significantly with average grades in upper division physics courses at the .05 level ($r = .713$). The combination of average grades in prerequisite chemistry, mathematics, and physics courses yielded a significant multiple correlation with the average grades received in upper division physics courses ($R = .886$, $p < .01$). The R^2 (corrected for shrinkage) indicated that 69.3% of the variance in average upper division physics grades was accounted for by lower division prerequisites.

Discussion

This study strongly supports the hypothesis that grades in major prerequisite courses are accurate predictors of upper division grades in the major area. Grades in prerequisite courses accounted for very high percentages (44%-73%) of the variance in major area grades in the seven science majors studied. Therefore, these results support the validity of prerequisites in relation to their function of presentation of essential content and problem solving methods and suggests that prerequisites are an appropriate selection mechanism to screen the most qualified students for particular major areas of study.

It is interesting to note that lower division physics grades are the best predictor for major area grades in four of the seven areas, while mathematics grades are the best predictor in two of the remaining three areas. This may be a result of the emphasis

on quantitative problem solving in physics and mathematics courses. If it is true that techniques are used in advanced areas of many sciences, then it is not surprising that facility with these techniques is predictive of success.

It is also interesting to note that lower division biology grades are not the best predictor of upper division biology grades in the Revelle major, nor are lower division chemistry grades the best predictor of upper division chemistry grades for chemistry majors. Similarly, lower division mathematics grades are not the best predictors of upper division mathematics grades for mathematics majors; nor are lower division physics grades the best predictor of upper division physics grades for physics majors. The implications of these findings are unclear. It is possible that mathematics and physics grades (the best predictors in six out of seven major areas) correlate with general quantitative ability which, in turn, correlates with success in advanced science coursework.

These results also suggest the possibility of the development of a formal system for prediction of major area grades. Prediction equations could be generated and validated on the basis of data from graduating classes over a period of several years. These prediction equations could than be used in conjunction with a student's lower division record to predict future performance in upper division major area courses. This formal prediction system could be a valuable aid for counselors and

academic advisors in helping students make decisions on future areas for study.

Summary

A study was conducted to determine the relationship between grades received in prerequisite biology, chemistry, mathematics, and physics courses and subsequent average grades received in science major areas. Seven major areas were investigated. Subjects were students who graduated from the University of California, San Diego (UCSD), in Spring, 1975, who had taken both their science major coursework and their lower division coursework at UCSD. The range of multiple correlations between prerequisite courses and average grades in major was .715 to .899. The results support the validity of prerequisite courses as predictors of success in major areas of study, even though the best predictors for success in a given field were not always courses in the same content area. Implications for future systems of diagnosis and prediction are made.

Reference

McNemar, Q. Psychological Statistics (4th ed.) New York: John Wiley, 1969.